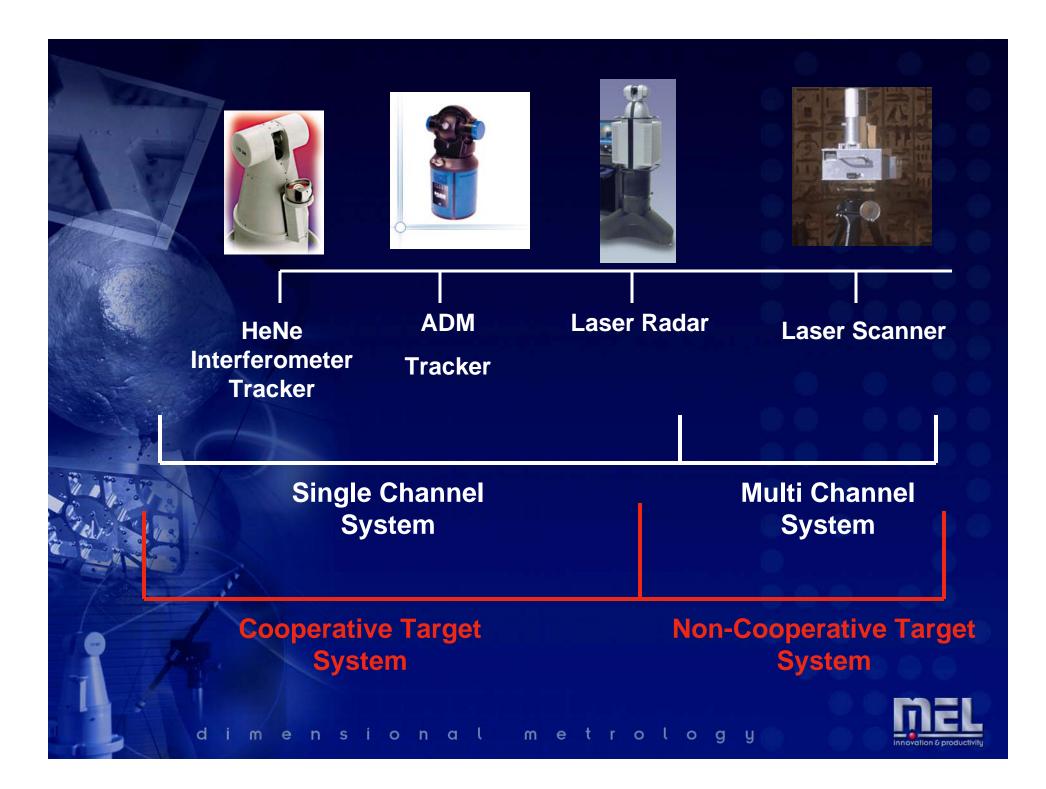
Laser Tracker Standard Update and the NIST 60 m Ranging Facility Steve Phillips **Dimensional Metrology Program Manger** National Institute of Standards and Technology Technology Administration, U.S. Department of Commerce



- Trackers, Laser Radar, & Laser Scanners
- ANSI / ASME B89.4.19 Standard
 - Ranging Tests
 - Volumetric System Test
- Ranging Test Facilities
 - 60 m (200') Cooperative Target Range per B89
 - 65 m (215') Non-Cooperative Target Range
- Volumetric Test Facilities
 - Cooperative Targets per B89
 - Non-Cooperative Range (future)





ASME B89.4.19 Laser Tracker Standard

- Designed to Test Cooperative Target Systems
- Focused on mechanical manufacturing (Indoor) environment
- Does not address:
 - Outdoor Environments: Rain; Fog; Wind;...
 - NonCooperative Targets: Concrete; Wood; Dirt;...
 - Motion in the field of view
 - MulitChannel Systems (B89 considers pt-pt lengths)
- Status: In Press



B89.4.19: Two Page Spec. Sheet

AN AMERICAN NATIONAL STANDARD

Performance Evaluation of Laser Based Spherical Coordinate Measurement Systems

ASME B89.4.19-200X

DRAFT - WTE Friday November 25, 2005

This draft is only for working purposes of the B89.4.19 Committee. Do not distribute

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Three Park Avenue New York, NY 10016-5990

Form 3.1 General Specifications and Rated Conditions

General Specifications and Rated Conditions						
RATED CONDITIONS						
Measurement envelope						
Distance	Min.		meters	Max.		
Range of horizontal angles						degrees
Range of vertical angles					_	degrees
a. Temperature Range						
Operating	Min.	•	0	Max.		С
Thermal Gradient Limits	Max		C/meter	Max.		C/hr max.
b. <u>Humidity Range</u> Operating	Min	96	BH	Max		NRH.
operani,					_	
c. Barometric Pressure Range						
Operating	Min.	mm	Hg	Max.		mm Hg
d. <u>Ambient light</u> - The manufacturer specifications.	shall identify con	ditions, if a	any, und	er which	n ambler	t light degrade
e. <u>Electrical</u> - The electrical power sup						
repeatable measurements. for any control or readout f		true when	a mach	ine uses	some to	rm of computer
Voltage	unction.	w				
Frequency		_ V _ Hz		Curren	·—:	
Max Transient Voltages an	d duration:	_ v	00	rgeroag	=;	
f. <u>Probe Type</u> - The probe diameter a performance testing shall be Diameter	e specified.					-
performance testing shall be						-
performance testing shall be Diameter g. <u>Sampling Strategy</u> - The manufact and sampling frequency (p	e specifiedmm urer shall state the	reflecto	r type: ment ac scificatio	quisition	time (av	eraging time)
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performance testing shall to Diameter 9. <u>Sampling Strategy</u> - The manufact and sampling frequency (p Acquisition time: LIMITING CONDITIONS h. <u>Temperature Range</u>	e specifiedmm urer shall state the oints per second) ts Min	reflecto e measurei to meet spe Freque	r type: ment ac coficatio ncy:	quisition n.	time (av points/s	eraging time)
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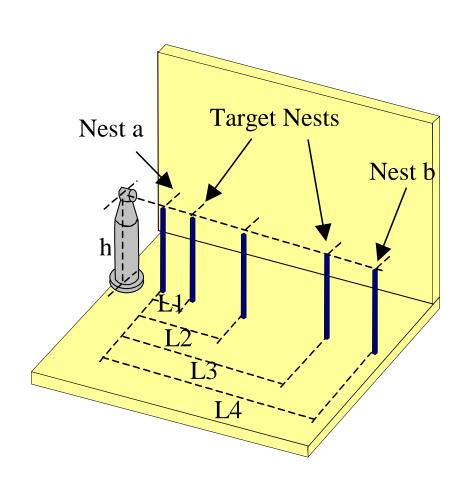
Form 3.2 MPE Specifications and Test Results

Test (positions) MPE _{INM} S _{text} or Press MPE _{ADM} S _{text} or Acasa* Horizontal (1) Acasa* Horizontal (2,3,4,5) Horizontal (6,7,8,9) Vertical (2,3,4) Vertical (2,3,4) Vertical (3,6,7,8) Right Diagonal (1,2,3,4) Right Diagonal (1,2,3,4) Left Diagonal (1,2,3,4) Left Diagonal (1,2,3,4) Left Diagonal (1,2,3,4) Left Diagonal (1,6,7,8) Left Diagonal (1,6,7,8) Left Diagonal (1,6,7,8) Left Diagonal (1,2,3,4) Left Diagonal (1,2,3,	pecifications a	IFM Specifications and Test Results				
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Horizontal (6,7,8,9) Vertical (1,2,3,4) Vertical (1,2,3,4) Vertical (1,2,3,4) Vertical (1,2,3,4) Right Diagonal (1,2,3,4) Right Diagonal (1,2,3,4) Left Diagonal (1						Horizontal (2.3.4.5)
Vertical (5.6.7.8) Right Diagonal (1.2.3.4) Right Diagonal (1.2.3.4) Right Diagonal (1.2.3.4) Right Diagonal (5.6.7.8) Left Diagonal (1.2.3.4) Left Diagonal (1.						
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User Selected (2)	1 1					
Two Face (5,6.7.8) Two Face (5,0.1.12)						
Two Face (5,6.7.8) Two Face (5,0.1.12)	†			t		Two Face (1,2,3,4)
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† Two-Face Tests may be performed with either an IFM or an ADM		2	1 and 7	sections 7	ce results: see	* δ for length system results. Δ for Two-Fa
		-				
‡ These results can be: results from long reference lengths, or computed from short reference (see Section 7.3.1), or computed from the laser interferometer calibration certificate (see Section 7.						

10



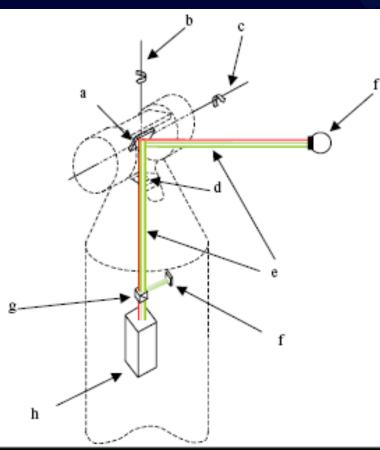
Ranging Test using 6 Calibrated Lengths (NIST supported calibration)



Position number.	Reference Lengths (R =Maximum Ranging Distance)
1	<i>L</i> ₁ ≈ 18% R
2	$L_2 \approx 36\% R$
3	$L_3 \approx 54\% R$
4	$L_4 \approx 72\% R$
5	User selected
6	User selected

Volumetric System Tests: Check Optical-Mechanical Alignments



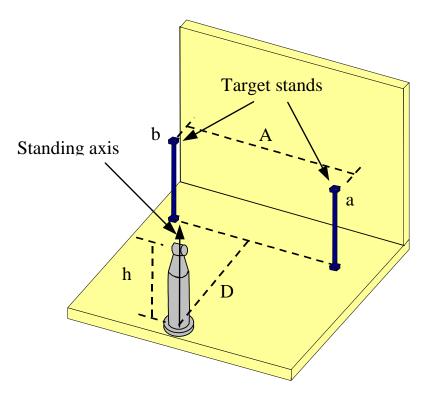


- a. Beam steering turning mirror
- b. Standing or vertical axis
- c. Horizontal or transit axis
- d. Cover plate
- e. Laser beam

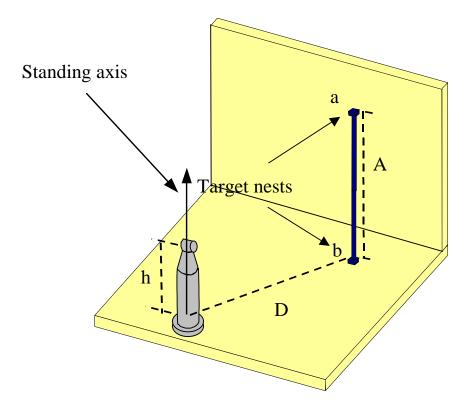
- f. Position Sensing Device (PSD)
- g. Beam splitting interferometer
- h. Laser head
- Spherically Mounted Retroreflector (SMR)

Volumetric System Tests

Horizontal Positions



Vertical Positions

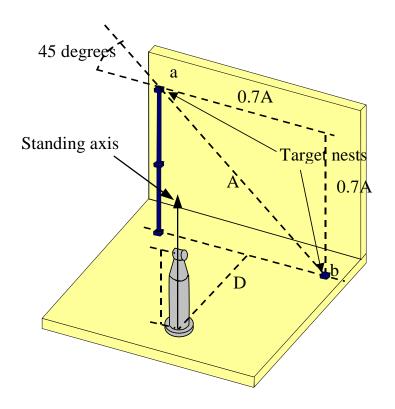


Volumetric System Tests

Right Diagonal Position

0.7A a 45 degrees anding axis D

Left Diagonal Position

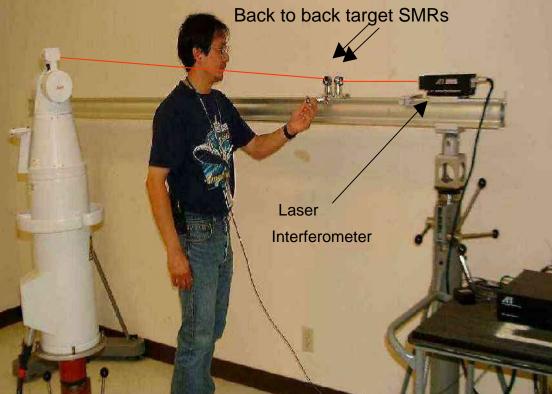


B89.4.19 Volumetric System Tests: Can be Tested with Laser Rail



(NIST Supported Calibration)

SMR(s)



NIST 60 m Ranging Facility





NIST 1D Range Facility Cooperative Or Non-Cooperative Targets

System configuration

Carriage can accommodate a variety of targets

Interferometer

Instrument under test



Target retroreflector

Reference retroreflector

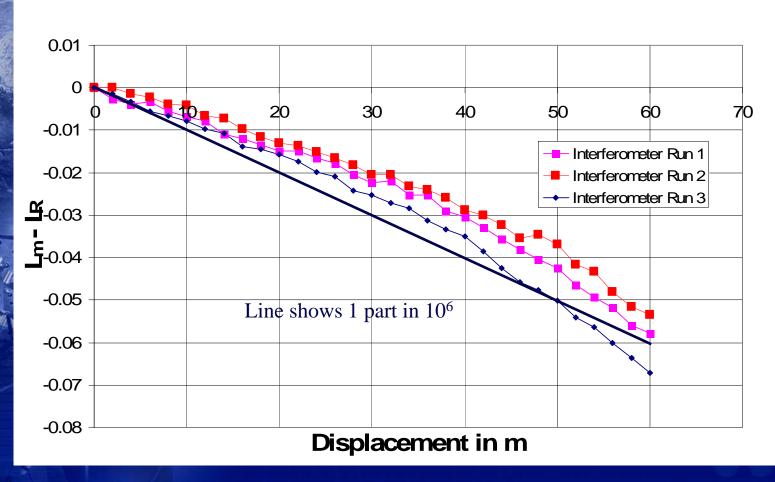
dimensional

innovation & productivit





Ranging Test (Dense Data)



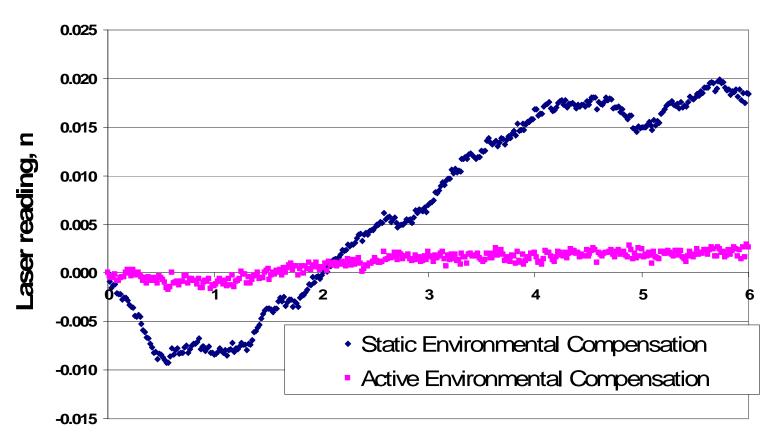
Stability test setup

Interferometer attached to wall

61 m



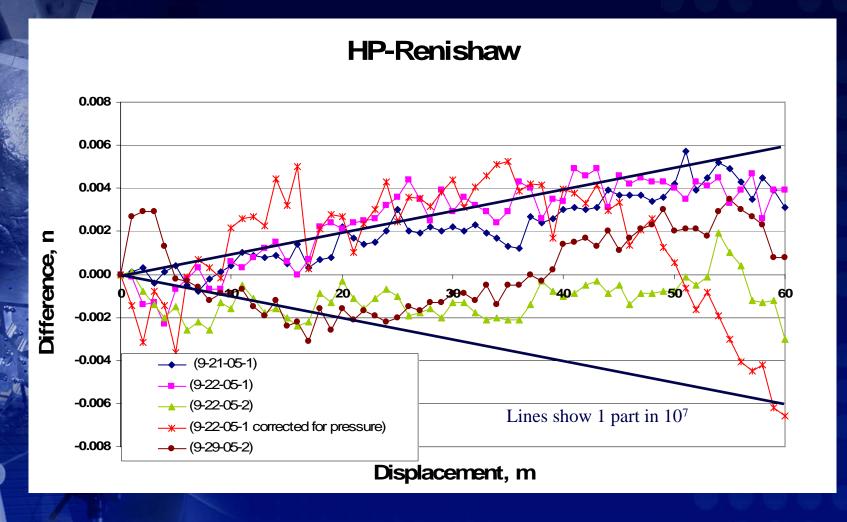




Time, Hours



NIST 1-D Range Facility Back-to-Back Comparison







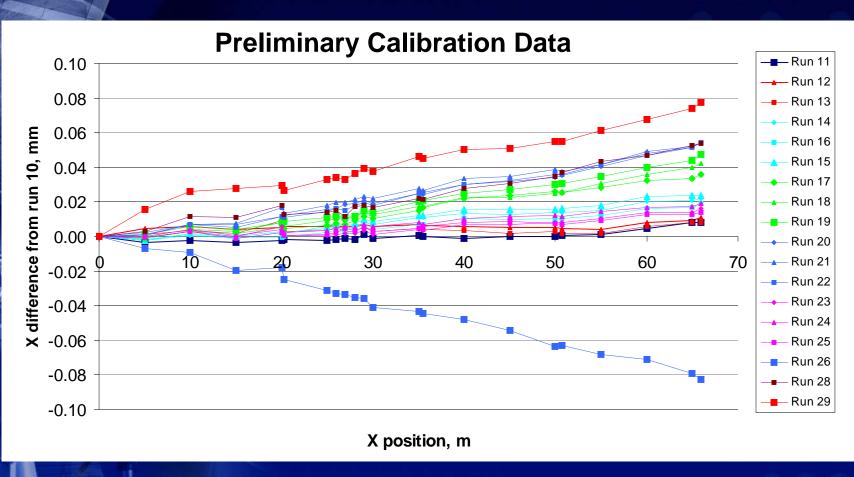
- 65 meters (215')
- 100 mm Dia Ti Spheres with passive reflectance
- 17 Positions





NIST NonCooperative Target Range

X Positions of Monuments- differences



NIST Calibrations

- 1D Range Test: Cooperative Target per B89 $U(k=2) = 10 \ \mu m + 5 \times 10^{-7} \ L \ \mu m$ (Non-Cooperative Targets also possible) NIST Calibration Available (\$800)
- 1D Range Test: Non-Cooperative Targets
 100 mm Dia Spheres:
 U(k=2) = 25 μm + 2 × 10⁻⁶ L μm
 NIST Calibration: Coming Soon!
- Volumetric System Test: Cooperative Target per B89:
 U(k=2) = 2 μm + 1.5 × 10⁻⁶ L μm
 NIST Calibration Available (\$1000)



Future B89.4.19 Standards work

- Next Meeting:May 3, 2006 Atlanta GA
- Topic:

NonCooperative Target Systems for Manufacturing



Thank you

Q & A

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